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Substrate materials for transparent injection-moulded parts

The present invention provides polycarbonates as a substrate material for the production of transparent injection-moulded parts, in particular for the production of injection-moulded parts and mouldings which are to be coated and are obtainable from the polycarbonates according to the invention. Mouldings can be e.g. transparent sheets, lenses, optical storage media or carriers for optical storage media or also articles from the automotive glazings sectors, such as e.g. diffusing screens. The present invention provides, in particular, optical storage media and carriers for optical storage media, such as e.g. writable optical data storage media which have a good coatability and wetting capacity and are suitable e.g. for application of dyestuffs from solution, in particular from non-polar media. The optical injection-moulded parts from the polycarbonates according to the invention furthermore have a relatively low tendency towards soiling.

Transparent injection-moulded parts are of importance above all in the glazings and storage media sector.

Optical data recording materials are increasingly being used as a variable recording and/or archiving medium for large amounts of data. Examples of this type of optical data storage media are CD, super-audio-CD, CD-R, CD-RW, DVD, DVD-R, DVD+R, DVD-RW, DVD+RW and BD.

Transparent thermoplastics, such as, for example polycarbonate, polymethyl methacrylate and chemical modifications thereof, are typically employed for optical storage media. Polycarbonate as a substrate material is suitable, in particular, for optical disks which are writable once and readable several times and also for those which are writable several times, and for the production of mouldings from the automotive glazing sector, such as e.g. diffusing screens. This thermoplastic has an excellent mechanical stability, has a low susceptibility to changes in dimensions and is distinguished by a high transparency and impact strength.



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According to DE-A 2 119 799, polycarbonates are prepared, with the involvement of phenolic end groups, by the phase interface process and also the process in a homogeneous phase.

5 Polycarbonate prepared by the phase interface process can be used for the production of optical data storage media of the formats described above, such as e.g. for compact disks (CD) or digital versatile disks (DVD). These disks often have the property of building up a high electrical field during their production in the injection moulding process. This high field strength on the substrate during production of the
10 optical data storage media leads e.g. to attraction of dust from the environment or to sticking of the injection-moulded articles, such as e.g. the disks, to one another, which reduces the quality of the finished injection-moulded articles and makes the injection moulding process difficult.

15 It is furthermore known that electrostatic charging, in particular of disks (for optical data carriers), leads to a lack of wettability, above all with non-polar media, such as e.g. a non-polar dyestuff or a dyestuff application from solvents, such as e.g. dibutyl ether, ethylcyclohexane, tetrafluoropropanol, cyclohexane, methylcyclohexane or octafluoropropanol. Thus, a high electrical field on the surface of the substrate
20 during the application of dyestuffs on writable data storage media causes, for example, an irregular coating with dyestuff and therefore leads to defects in the information layer.

The degree of electrostatic charging of a substrate material can be quantified e.g. by
25 measurement of the electrical field at a particular distance from the substrate surface.

In the case of an optical data storage medium in which a writable substrate is applied to the surface in a spin coating process, a low absolute electrical field strength is necessary in order to guarantee uniform application of the writable layer and to
30 ensure a trouble-free production process.

Because of the facts described above, a high electrostatic field moreover causes losses in yield in respect of the substrate material. This can lead to a stop in the particular production step and is associated with high costs.

- 5 Several paths have been followed to solve this problem of high static charging. In general, antistatics are added to the substrate material as additives. Antistatic polycarbonate compositions are described e.g. in JP 62 207 358-A. In this specification, phosphoric acid derivatives, inter alia, are added to the polycarbonate as antistatics. EP 0922 728 describes various antistatics, such as polyalkylene glycol
- 10 derivatives, ethoxylated sorbitan monolaurate, polysiloxane derivatives, phosphine oxides and distearylhydroxyamine, which are employed individually or as mixtures. The Japanese Application JP 62 207 358 describes esters of phosphorous acid as additives. US Patent 5,668,202 describes sulfonic acid derivatives. US-A 6,262,218 and 6,022,943 describes the use of phenyl chloroformate in order to increase the end
- 15 group content in melt polycarbonate. According to this application, an end group content of > 90 % is said to have a positive effect on the electrostatic properties. In WO 00/50 488, 3,5-di-tert-butylphenol is employed as a chain terminator in the phase interface process. This chain terminator leads to a lower static charging of the corresponding substrate material compared with conventional chain terminators.
- 20 JP 62 207 358-A describes polyethylene derivatives and polypropylene derivatives as additives for polycarbonate. EP-A 1 304 358 describes the use of short oligomers, such as e.g. bisphenol A bis-(4-tert-butylphenyl carbonate) in polycarbonate from the transesterification process.
- 25 However, the additives described can also have an adverse effect on the properties of the substrate material, since they tend to emerge from the material. This is indeed a desirable effect for the antistatic properties, but can lead to formation of a deposit or defective moulding. The content of oligomers in the polycarbonate can moreover also lead to a poorer level of mechanical properties and to a lowering of the glass
- 30 transition temperature. These additives can furthermore cause side reactions. Subsequent "end-capping" of polycarbonate which has been obtained from the

transesterification process is expensive and the results achieved are not optimum. The introduction of new end groups into the material is associated with high costs.

5 The object is therefore to provide a composition or a substrate material which meets the requirements of a lowest possible electrical field on the substrate surface and avoids the disadvantages described above.

Those substrate materials which comprise no additives or the smallest possible amount of additives are advantageous above all. Thus e.g. the antistatics described
10 in EP-A 922 728, such as polyoxyethylene sorbitan monolaurate, polyoxyethylene monolaurate and polyoxyethylene monostearate, are indeed active in respect of the antistatic properties in the amounts added, of 50 - 200 ppm, but can be a disadvantage for the overall performance of the injection-moulded article, as described above.

15 These materials thus show initially good antistatic properties, which disappear, however, in the course of a continuous injection moulding process. As described above, the additives can emerge from the material and in the case of a continuous injection moulding process in this way lead to surface defects on the mouldings or
20 also to malfunctions in the production process. The antistatic action initially present can also be lost and lead to high electrostatic fields on the mouldings.

It is therefore advantageous to employ a substrate material which as far as possible contains no antistatic additives.

25 The material can moreover also comprise additional additives, e.g. flameproofing agents, mould release agents, UV stabilizers and heat stabilizers, such as are known for aromatic polycarbonates. Nevertheless, the amount of additives employed is to be kept as low as possible for the reasons described above. Examples of such
30 additives are mould release agents based on stearic acid and/or stearyl alcohol, particularly preferably pentaerythritol stearate, trimethylolpropane tristearate,

pentaerythritol distearate, stearyl stearate and glycerol monostearate, as well as heat stabilizers based on phosphanes, phosphites and phosphoric acid.

5 The present invention provides a substrate material which can be used in particular for rewritable optical data carriers having a good coatability and wettability and low tendency towards soiling. The substrate material according to the invention leads to a low rate of rejects in the production process.

10 It has been found, surprisingly, that the electrostatic field which arises on the particular injection-moulded parts in the course of the injection moulding process is not constant during the production process but follows a particular course of the field strength. It has thus been found, surprisingly, that in the case of polycarbonate produced by the phase interface process, the field strength on the particular disks increases after the start of the injection moulding process (provided a new template is inserted) and reaches a plateau or increases further only a little after a certain period of time. This was not known hitherto and is significantly an important criterion for the performance of the injection-moulded part in the subsequent production step in which e.g. the dyestuff is applied to the substrate. With the substrate materials according to the invention, initially high electrical fields can occur on corresponding injection-moulded articles which are produced in a continuous production process. Nevertheless, the value of the electrical field already lies in an acceptable range after a short time and changes further only little per unit time. The overall reject rate during the continuous injection moulding process is therefore significantly lower compared with conventional substrate materials.

25 As a decisive quality feature for the coating of injection-moulded parts, in particular for the coating of transparent optical disks or of transparent diffusing screens, it has thus been found, surprisingly, that substrate materials which prove to have a positive effect in the context of the invention are above all those which do not exceed a particular field strength, measured at a defined distance from the substrate surface and at a defined temperature and atmospheric humidity, after a particular production

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time. It has furthermore been found that the change in the electrical field per unit time should not exceed a particular gradient.

5 The present invention therefore provides a substrate material, preferably polycarbonate prepared by the phase interface process, for the production of transparent injection-moulded parts which are to be coated, which delivers disks with an electrical field, measured at a distance of 100 mm from the substrate surface, of between -30 and 0 kV/m, preferably between -20 and 0 kV/m, within the first 5 minutes of the injection moulding process, and delivers disks with an E field of 10 between 0 and 25 kV/m, and particularly preferably of between 0 and +18 kV/m, after 180 to 185 minutes. The present invention furthermore provides a substrate material, preferably polycarbonate, prepared by the phase interface process, which does not exceed an integral average value of the field of +18 kV/m, measured at a distance of 100 mm from the corresponding injection-moulded articles (measured at 15 a distance of 100 mm from the substrate surface), after 3 hours of a continuous injection moulding process.

The electrical field caused by surface charges on the corresponding substrate substantially depends on the geometry and the dimensions of the injection-moulded 20 article and the nature of the injection moulding process. It is therefore important to carry out the measurement on the injection-moulded article, which is to be coated, itself, such as e.g. a disk for an optical data carrier.

25 All the values described above and measured apply to mouldings which have been produced via an injection process, which is known in principle, at a certain atmospheric humidity and room temperature without the use of ionizers.

In order to ensure a good writability of the disks in the production process, so-called ionizers which conduct a stream of ionized air over the disks are often employed. 30 The abovementioned measurement values for substrate materials according to the invention have been achieved without the use of ionizers. This is a further

advantage of the invention, since the use of ionizers makes the production process more expensive. Nevertheless, ionizers can additionally be employed.

5 The present invention also provides the mouldings produced from the substrate materials according to the invention, such as e.g. disks for writable optical data storage media or materials from the automotive glazings sectors, such as e.g. diffusing screens.

10 Materials which are suitable for the production of the coatable transparent injection-moulded parts, preferably optical data storage media, are:

thermoplastics, such as polycarbonate based on bisphenol A (BPA-PC), polycarbonate based on trimethyl-cyclohexyl-bisphenol polycarbonate (TMC-PC), fluorenyl polycarbonate, polymethyl methacrylate, cyclic polyolefin copolymer, 15 hydrogenated polystyrenes (HPS) as well as amorphous polyolefins and polyesters.

Polycarbonate is particularly suitable for the production of the coatable transparent injection-moulded parts.

20 The substrate materials according to the invention and injection-moulded articles obtainable therefrom, in particular disks, can be produced by the choice of suitable process parameters.

25 The course of the field strength on an injection-moulded article, as has been described above, can be influenced by several factors. For example, the purity of the educts and auxiliary substances is of importance. Furthermore, process parameters such as the molar ratio of the bisphenol employed and phosgene, temperatures during the reaction, reaction and dwell times, can be decisive. For the person skilled in the art, the object is to control the process such that the limits according to the 30 invention in the course of the field strength (measured on appropriate injection-moulded parts) are not exceeded. The measurement described for the course of the

field strength is a suitable instrument for controlling the process for the person skilled in the art.

5 A suitable choice of process parameters in order to obtain the desired substrate material can appear as follows:

One possibility for producing the substrate material according to the invention is the choice of certain process parameters during the preparation of the substrate material in a continuous phase interface process. While the excess of phosgene used, based on the total of bisphenols employed, is between 3 and 100 mol%, preferably between 5 and 50 mol%, in conventional continuous polycarbonate synthesis, the substrate material according to the invention is prepared at phosgene excesses of from 5 to 20 mol%, preferably 8 to 17 mol%. In this context, the pH of the aqueous phase during and after the metering of the phosgene is kept in the alkaline range, preferably between 8.5 and 12, by subsequent metering of sodium hydroxide solution once or several times or appropriate subsequent metering of bisphenolate solution, while it is adjusted to 10 to 14 after addition of the catalyst. The temperature during the phosgenation is 0 °C to 40 °C, preferably 5 °C to 36 °C.

20 The polycarbonates according to the invention are prepared by the phase interface process. This process for polycarbonate synthesis is described in many instances in the literature; reference may be made by way of example to H. Schnell, Chemistry and Physics of Polycarbonates, Polymer Reviews, vol. 9, Interscience Publishers, New York 1964 p. 33 et seq., to Polymer Reviews, vol. 10, "Condensation Polymers by Interfacial and Solution Methods", Paul W. Morgan, Interscience Publishers, New York 1965, chap. VIII, p. 325, to Dres. U, Grigo, K. Kircher and P.R. Müller "Polycarbonate" in Becker/Braun, Kunststoff-Handbuch, vol. 3/1, Polycarbonate, Polyacetale, Polyester, Celluloseester, Carl Hanser Verlag Munich, Vienna 1992, p. 118-145 and to EP-A 0 517 044.

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According to this process, the phosgenation of a disodium salt of a bisphenol (or of a mixture of various bisphenols) which has been initially introduced into an aqueous-

alkaline solution (or suspension) is carried out in the presence of an inert organic solvent or solvent mixture which forms a second phase. The oligocarbonates formed, which are chiefly present in the organic phase, are subjected to further condensation with the aid of suitable catalysts to give high molecular weight polycarbonates dissolved in the organic phase. Finally, the organic phase is separated off and the polycarbonate is isolated therefrom by various working up steps.

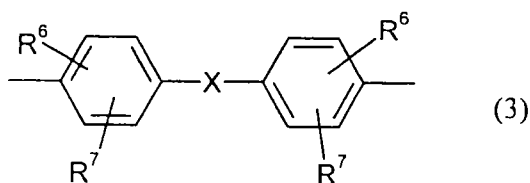
Dihydroxyaryl compounds which are suitable for the preparation of polycarbonates are those of the formula (2)



in which

Z is an aromatic radical having 6 to 30 C atoms, which can contain one or more aromatic nuclei, can be substituted and can contain aliphatic or cycloaliphatic radicals or alkylaryls or heteroatoms as bridge members.

Preferably, Z in formula (2) represents a radical of the formula (3)



in which

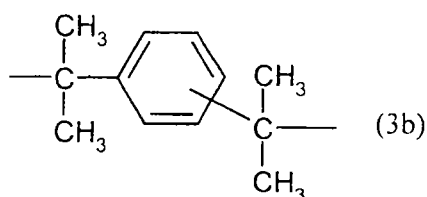
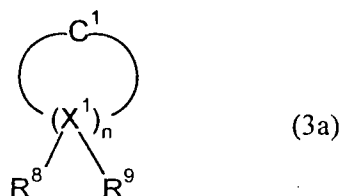
R^6 and R^7 independently of one another represent H, $\text{C}_1\text{-C}_{18}$ -alkyl, $\text{C}_1\text{-C}_{18}$ -alkoxy, halogen, such as Cl or Br, or in each case optionally substituted aryl or aralkyl, preferably H or $\text{C}_1\text{-C}_{12}$ -alkyl, particularly preferably H or $\text{C}_1\text{-C}_8$ -alkyl, and very particularly preferably H or methyl, and

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X represents a single bond, -SO₂-, -CO-, -O-, -S-, C₁- to C₆-alkylene, C₂- to C₅-alkylidene or C₅- to C₆-cycloalkylidene, which can be substituted by C₁- to C₆-alkyl, preferably methyl or ethyl, and furthermore C₆- to C₁₂-arylene, which can optionally be fused with further aromatic rings containing heteroatoms.

Preferably, X represents a single bond, C₁ to C₅-alkylene, C₂ to C₅-alkylidene, C₅ to C₆-cycloalkylidene, -O-, -SO-, -CO-, -S-, -SO₂-,

or a radical of the formula (3a) or (3b)



wherein

R^8 and R^9 can be chosen individually for each X^1 and independently of one another denote hydrogen or C₁ to C₆-alkyl, preferably hydrogen, methyl or ethyl, and

X^1 denotes carbon and

n denotes an integer from 4 to 7, preferably 4 or 5, with the proviso that on at least one atom X^1 , R^8 and R^9 are simultaneously alkyl.

Examples of dihydroxyaryl compounds are: dihydroxybenzenes, dihydroxydiphenyls, bis-(hydroxyphenyl)-alkanes, bis-(hydroxyphenyl)-cycloalkanes, bis-(hydroxyphenyl)-aryls, bis-(hydroxyphenyl) ethers, bis-

(hydroxyphenyl) ketones, bis-(hydroxyphenyl) sulfides, bis-(hydroxyphenyl) sulfones, bis-(hydroxyphenyl) sulfoxides, 1,1'-bis-(hydroxyphenyl)-diisopropylbenzenes and nucleus-alkylated and nucleus-halogenated compounds thereof.

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Diphenols which are suitable for the preparation of the polycarbonates to be used according to the invention are, for example, hydroquinone, resorcinol, dihydroxydiphenyl, bis-(hydroxyphenyl)-alkanes, bis-(hydroxyphenyl)cycloalkanes, bis-(hydroxyphenyl) sulfides, bis-(hydroxyphenyl) ethers, bis-(hydroxyphenyl) ketones, bis-(hydroxyphenyl) sulfones, bis-(hydroxyphenyl) sulfoxides, α,α' -bis-(hydroxyphenyl)-diisopropylbenzenes and alkylated, nucleus-alkylated and nucleus-halogenated compounds thereof.

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Preferred diphenols are 4,4'-dihydroxydiphenyl, 2,2-bis-(4-hydroxyphenyl)-1-phenyl-propane, 1,1-bis-(4-hydroxyphenyl)-phenyl-ethane, 2,2-bis-(4-hydroxyphenyl)propane, 2,4-bis-(4-hydroxyphenyl)-2-methylbutane, 1,3-bis-[2-(4-hydroxyphenyl)-2-propyl]benzene (bisphenol M), 2,2-bis-(3-methyl-4-hydroxyphenyl)-propane, bis-(3,5-dimethyl-4-hydroxyphenyl)-methane, 2,2-bis-(3,5-dimethyl-4-hydroxyphenyl)-propane, bis-(3,5-dimethyl-4-hydroxyphenyl) sulfone, 2,4-bis-(3,5-dimethyl-4-hydroxyphenyl)-2-methylbutane, 1,3-bis-[2-(3,5-dimethyl-4-hydroxyphenyl)-2-propyl]-benzene and 1,1-bis-(4-hydroxyphenyl)-3,3,5-trimethylcyclohexane (bisphenol TMC).

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Particularly preferred diphenols are 4,4'-dihydroxydiphenyl, 1,1-bis-(4-hydroxyphenyl)-phenylethane, 2,2-bis-(4-hydroxyphenyl)-propane, 2,2-bis-(3,5-dimethyl-4-hydroxyphenyl)-propane, 1,1-bis-(4-hydroxyphenyl)-cyclohexane and 1,1-bis-(4-hydroxyphenyl)-3,3,5-trimethylcyclohexane (bisphenol TMC).

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These and further suitable diphenols are described e.g. in US-A 2 999 835, 3 148 172, 2 991 273, 3 271 367, 4 982 014 and 2 999 846, in the German Offenlegungsschriften 1 570 703, 2 063 050, 2 036 052, 2 211 956 and 3 832 396, the French Patent Specification 1 561 518, in the monograph "H. Schnell, Chemistry

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and Physics of Polycarbonates, Interscience Publishers, New York 1964, p. 28 et seq.; p. 102 et seq." and in "D.G. Legrand, J.T. Bendler, Handbook of Polycarbonate Science and Technology, Marcel Dekker New York 2000, p. 72 et seq.".

5 In the case of the homopolycarbonates, only one diphenol is employed, and in the case of copolycarbonates two or more diphenols are employed. The diphenols used, like all other chemicals and auxiliary substances added to the synthesis, may be contaminated with the impurities originating from their own synthesis, handling and storage. However, it is desirable to use raw materials which are as pure as possible.

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The monofunctional chain terminators required for regulating the molecular weight, such as phenol or alkylphenols, in particular phenol, p-tert-butylphenol, iso-octylphenol, cumylphenol, chlorocarbonic acid esters thereof or acid chlorides of monocarboxylic acids or mixtures of these chain terminators, are either fed with the
15 bisphenolate or the bisphenolates to the reaction or added to the synthesis at any desired point in time, as long as phosgene or chlorocarbonic acid end groups are still present in the reaction mixture or, in the case of acid chlorides and chlorocarbonic acid esters as chain terminators, as long as sufficient phenolic end groups of the polymer forming are available. Preferably, however, the chain terminator or
20 terminators are added after the phosgenation, at a place or at a point in time when phosgene is no longer present but the catalyst has not yet been metered in, or they are metered in before the catalyst, together with the catalyst or in parallel thereto.

In the same manner, any branching agents or branching agent mixtures to be used
25 are added to the synthesis, but conventionally before the chain terminators. Trisphenols, quaternary phenols or acid chlorides or tri- or tetracarboxylic acids, or also mixtures of the polyphenols or of the acid chlorides, are conventionally used.

Some of the compounds which have three or more than three phenolic hydroxyl
30 groups and can be used are, for example,

phloroglucinol,

4,6-dimethyl-2,4,6-tri-(4-hydroxyphenyl)-hept-2-ene,

4,6-dimethyl-2,4,6-tri-(4-hydroxyphenyl)-heptane,

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1,3,5-tri-(4-hydroxyphenyl)-benzene,

1,1,1-tri-(4-hydroxyphenyl)-ethane,

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tri-(4-hydroxyphenyl)-phenylmethane,

2,2-bis-(4,4-bis-(4-hydroxyphenyl)-cyclohexyl]-propane,

2,4-bis-(4-hydroxyphenylisopropyl)-phenol,

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tetra-(4-hydroxyphenyl)-methane.

Some of the other trifunctional compounds are 2,4-dihydroxybenzoic acid, trimesic acid, cyanuric chloride and 3,3-bis-(3-methyl-4-hydroxyphenyl)-2-oxo-2,3-dihydroindole.

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Preferred branching agents are 3,3-bis-(3-methyl-1,4-hydroxyphenyl)-2-oxo-2,3-dihydroindole and 1,1,1-tri-(4-hydroxyphenyl)-ethane.

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The catalysts used in the phase interface synthesis are tertiary amines, in particular triethylamine, tributylamine, trioctylamine, N-ethylpiperidine, N-methylpiperidine and N-i/n-propylpiperidine; quaternary ammonium salts, such as tetrabutylammonium / tributylbenzylammonium / tetraethylammonium hydroxide / chloride / bromide / hydrogen sulfate / tetrafluoroborate; and the phosphonium compounds corresponding to the ammonium compounds. These compounds are described as typical phase interface catalysts in the literature, are commercially obtainable and are familiar to the person skilled in the art. The catalysts can be

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added to the synthesis individually, in a mixture or also side by side and successively, optionally also before the phosgenation, but meterings after the introduction of phosgene are preferred, unless an onium compound or mixtures of onium compounds are used as catalysts, in which case an addition before the metering of phosgene is preferred. The catalyst or catalysts can be metered in bulk, in an inert solvent, preferably that of the polycarbonate synthesis, or also as an aqueous solution, and in the case of the tertiary amines then as ammonium salts thereof with acids, preferably mineral acids, in particular hydrochloric acid. If several catalysts are used or part amounts of the total amount of catalysts are metered, various methods of metering can of course also be carried out at various places or at various times. The total amount of catalysts used is between 0.001 to 10 mol%, based on the moles of bisphenols employed, preferably 0.01 to 8 mol%, particularly preferably 0.05 to 5 mol%.

The conventional additives for polycarbonates can also be added in the conventional amounts to the polycarbonates according to the invention. The addition of additives serves to prolong the useful life or the colour (stabilizers), simplify processing (e.g. mould release agents, flow auxiliaries, antistatics) or adapt the polymer properties to particular stresses (impact modifiers, such as rubbers; flameproofing agents, colouring agents, glass fibres).

These additives can be added to the polymer melt individually or in any desired mixtures or several different mixtures, and in particular directly during isolation of the polymer or after melting of granules, in a so-called compounding step. In this context, the additives or mixtures thereof can be added to the polymer melt as a solid, i.e. as a powder, or as a melt. Another method of metering is the use of masterbatches or mixtures of masterbatches of the additives or additive mixtures.

Suitable additives are described, for example, in "Additives for Plastics Handbook, John Murphy, Elsevier, Oxford 1999" and in "Plastics Additives Handbook, Hans Zweifel, Hanser, Munich 2001".

Preferred heat stabilizers are, for example, organic phosphites, phosphonates and phosphanes, usually those in which the organic radicals consist entirely or partly of optionally substituted aromatic radicals. UV stabilizers which are employed are e.g. substituted benzotriazoles. These and other stabilizers can be used individually or in combination and added in the forms mentioned to the polymer.

Processing auxiliaries, such as mould release agents, usually derivatives of long-chain fatty acids, can moreover be added. Pentaerythritol tetrastearate and glycerol monostearate e.g. are preferred. They are employed by themselves or in a mixture, preferably in an amount of from 0.02 to 1 wt.%, based on the weight of the composition.

Suitable flame-retardant additives are phosphate esters, i.e. triphenyl phosphate, resorcinol-diphosphoric acid esters, bromine-containing compounds, such as brominated phosphoric acid esters and brominated oligocarbonates and polycarbonates, and, preferably, salts of fluorinated organic sulfonic acids.

Suitable impact modifiers are, for example, graft polymers comprising one or more graft bases chosen from at least one polybutadiene rubber, acrylate rubber (preferably ethyl or butyl acrylate rubber) and ethylene/propylene rubbers, and graft monomers chosen from at least one monomer from the group consisting of styrene, acrylonitrile and alkyl methacrylate (preferably methyl methacrylate), or interpenetrating siloxane and acrylate networks with grafted-on methyl methacrylate or styrene/acrylonitrile.

Colouring agents, such as organic dyestuffs or pigments or inorganic pigments, IR absorbers, individually, in a mixture or also in combination with stabilizers, glass fibres, glass (hollow) beads and inorganic fillers, can furthermore be added.

The present Application furthermore provides the extrudates and mouldings obtainable from the substrate materials according to the invention, in particular those for use in the transparent sector, very particularly in the optical uses sector, such as

e.g. sheets, multi-wall sheets, glazing, diffusing screens and lamp covers, or optical data storage media, such as audio-CD, CD-R(W), DVD, DVD-R(W) and minidisks in their various only readable or once writable and optionally also repeatedly writable embodiments.

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The present invention furthermore provides the use of the polycarbonates according to the invention for the production of extrudates and mouldings.

10 The substrate material according to the invention, preferably polycarbonate, can be processed by injection moulding by known processes. A disk produced in this way can be e.g. an audio-CD or a super-audio-CD, CD-R, CD-RW, DVD, DVD-R, DVD+R, DVD-RW, DVD+RW or BR.

15 The CD-R (write once, read many) thus comprises a substrate having concentrically formed guide depressions (pregrooves) which are transferred from a nickel template in the injection moulding process. Via a template which has depressions on a sub-micrometre scale, these are transferred accurately to the surface of the substrate in the injection moulding process. The CD-R comprises the abovementioned substrate, a dyestuff recording layer, a reflection layer and protective layer, which are applied
20 or laminated on to the substrate in this sequence. Another example for a once-writable optical disk which can be read again several times is the DVD-R, which comprises the substrate, a dyestuff recording layer, a reflection layer and optionally a protective layer which are likewise applied in this sequence to the substrate described above and are glued with a second disk ("dummy disk").

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The dyestuff layer is applied via a "spin coating" process. In this production step, the particular dyestuff, dissolved in an organic solvent, is applied to the information layer of the substrate and introduced uniformly in the radial direction into the depressions of the substrate by rotation of the disk. After this step, the dyestuff layer
30 is dried.

The dyestuff to be used for the use described above has an absorption range which lies in the range of the laser used (300 - 850 nm). Examples of dyestuff types are e.g. cyanines, phthalocyanines, squarylium dyestuffs, polymethines, pyrilium and thiopyrilium dyestuffs, indoanilines, naphthoquinones, anthraquinones and various metal-chelate complexes, such as e.g. azo coordination compounds, cyanines or phthalocyanines. These dyestuffs have a good signal sensitivity and good solubility in organic solvents and light-fastness and are therefore preferred dyestuffs for the uses described above.

Examples of solvents are esters, such as butyl acetate, ketones, such as methyl ethyl ketone, cyclohexanone, methyl isobutyl ketone and 2,4-dimethyl-4-heptanone (DMH), chlorinated hydrocarbons, such as 1,2-dichloroethane and chloroform, amides, such as dimethylformamide, hydrocarbons, such as cyclohexane, methylcyclohexane or ethylcyclohexane, ethers, such as THF and dioxane, alcohols, such as ethanol, propanol, isopropanol, n-butanol and diacetone alcohol, fluorinated solvents, such as 2,2,3,3-tetrafluoropropanol, and glycol ethers, such as ethylene glycol monomethyl ether and propylene glycol monomethyl ether. These can be employed individually or as mixtures. Preferred solvents are fluorinated solvents, such as 2,2,3,3-tetrafluoropropanol, octafluoropentanol and dibutyl ether.

A reflection layer, e.g. comprising gold or silver, can be applied to the dyestuff layer via a sputtering method. A protective layer can optionally be applied to the reflection layer.

The disk substrate according to the invention and the optical disk according to the invention show clearly improved antistatic properties and improved coatability.

The injection-moulded part is obtained by conventional injection moulding processes. In the examples part of the present Application, the injection-moulded part is produced as follows:

An optical disk is chosen for production of the mouldings according to the invention; the following injection moulding parameters and conditions are established:

5 Machine: Netstal Discjet

Template: Audio stamper

Cycle time: 4.2 - 4.6 s (in the examples mentioned: 4.4 s)

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Melt temperature: 310 - 330 °C

Substrate dimensions: Audio-CD

15 Mould temperature on the template side: 60 °C

Before the start of the injection moulding process, a new audio stamper is inserted into the machine. Before the new stamper is inserted, the entire injection moulding unit must be cleaned from the preceding material so that the measurement values are not falsified.

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A field meter from Eltec (EMF 581230) is used to measure the electrical field strength. Immediately after the end of the injection moulding process, the moulding, in the examples part of the present Application a disk, is removed via a robot arm and stacked. During this operation the disk must not come into contact with metal, since otherwise the measurement is impaired. Furthermore, any ionizers present must be switched off.

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The field meter is positioned above the disk at a distance of 100 mm from the horizontal disk surface. The centre of the field meter is positioned such that its projection on the disk currently to be measured lies 39 mm outside the centre of the

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disk. The disk is not moved during this operation. The field is thus measured within a period of 3 - 10 seconds after conclusion of the injection moulding process.

5 The measuring instrument is connected to an x/y plotter, on which the particular values are printed out. Each disk measured is thus assigned a particular integral value of the electrical field. To limit the amount of data, 100 measurements were performed after the start of the process, i.e. the corresponding electrical field of the first 100 disks was recorded. 100 further measurement were carried out after every 60 minutes. After the 4th measurement series, i.e. after approx. 3 hours, the
10 measurement is stopped.

When carrying out the measurement, it is to be ensured that the atmospheric humidity during the measurement is 30 to 60 %, preferably 35 to 50 %, and the room temperature is 25 to 28 °C.

15 The dyestuff application can be carried out via "spin coating" as described above. A phthalocyanine is preferably used as the dyestuff and dibutyl ether is preferably used as the solvent. The application of dyestuff starts at a distance of 2 mm from the innermost track. The speed of rotation during application of the dyestuff is 200 rpm.
20 To distribute the solution over the entire disk, the speed is increased to 5,000 rpm.

The coatability with dyestuff is measured here by means of light microscopy examination of the inner region of the disk coated with dyestuff. If a deviation from the colour edge of 0.5 mm or higher is found at a place of the outer dyestuff edge,
25 the wetting properties of this disk are inadequate.

A further indirect possibility of measuring the coatability is that of checking the disk coated e.g. with dyestuff with a camera or laser system. In this case, the information recorded is evaluated via image processing software and wetting errors which occur
30 are recognized ("in-line" detection). Defective disks are automatically discarded.

Examples

Example 1:

- 5 The polycarbonate is prepared by the known phase interface process. A continuous process is used.

10 The bisphenolate solution (bisphenol A; alkali content 2.12 mol NaOH/mol BPA) is fed into the reactor at 750 kg/h (14.93 wt.%), the solvent (methylene chloride/chlorobenzene 1:1) at 646 kg/h and the phosgene at 56.4 kg/h and the components are reacted. The temperature in the reactor is 35 °C. Sodium hydroxide solution (32 wt.%) is furthermore also metered in at 9.97 kg/h. In the course of the condensation reaction, a second amount of sodium hydroxide solution (32 wt.%) is metered in at 29.27 kg/h, as well as a solution of chain terminators (11.7 wt.% tert-butylphenol in methylene chloride/chlorobenzene 1:1) at 34.18 kg/h. Thereafter, N-ethylpiperidine, dissolved in methylene chloride/chlorobenzene (1:1; 2.95 wt.% N-ethylpiperidine) is fed in at 33.0 kg/h as a catalyst. The phases are separated and the organic phase is washed once with dilute hydrochloric acid and five times with water. The polycarbonate solution is then concentrated, the concentrate is
20 concentrated in an evaporating tank and the polymer melt is spun off via a devolatilization extruder and granulated.

25 The granules obtained are dried for 6 hours and then processed to disks on a Netstal Discjet injection moulding machine (see above) over a cycle time of 4.4 seconds under the abovementioned parameters. An audio stamper is used as the template. The electrical field of each of the first 100 disks is measured with a field meter as described above. After one hour, a further 100 disks are measured in succession; the injection moulding process is not interrupted here. Furthermore, likewise in each case 100 disks are measured in succession after the 2nd and 3rd hour. The result of
30 the field measurement is shown in Fig. 1.

Fig. 1:

0 h : Measurement of the first 100 disks after the start of the injection moulding process

5 *1 h : Measurement of a further 100 disks after 60 minutes of a continuous injection moulding process*

2 h : Measurement of a further 100 disks after 120 minutes of a continuous injection moulding process

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3 h : Measurement of a further 100 disks after 180 minutes of a continuous injection moulding process

Example 2 (comparison example):

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The polycarbonate is prepared as described in Example 1. However, the bisphenolate solution (bisphenol A) is fed into the reactor at 750 kg/h (14.93 wt.%), the solvent (methylene chloride/chlorobenzene 1:1) at 646 kg/h and the phosgene at 58.25 kg/h. Sodium hydroxide solution (32 wt.%) is furthermore likewise metered in at 12.34 kg/h. The second amount of sodium hydroxide solution is 36.20 kg/h; the amount of chain terminators is 34.18 kg/h at the concentrations stated in Example 5. The amount of catalyst is 33 kg/h. Working up is carried out as described in Example 1.

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The granules obtained are dried for 6 hours and then processed to disks on a Netstal Discjet injection moulding machine (see above) over a cycle time of 4.4 seconds under the abovementioned parameters. An audio stamper is used as the template. The electrical field of each of the first 100 disks is measured with a field meter as described above. After one hour, a further 100 disks are measured in succession; the injection moulding process is not interrupted here. Furthermore, likewise in each case 100 disks are measured in succession after the 2nd and 3rd hour. The result of the field measurement is shown in Fig. 1.

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As is shown in Fig. 2, the field strengths on the injection-moulded parts measured clearly lie outside the range according to the invention.

5 *0 h : Measurement of the first 100 disks after the start of the injection moulding process*

1 h : Measurement of a further 100 disks after 60 minutes of a continuous injection moulding process

10

2 h : Measurement of a further 100 disks after 120 minutes of a continuous injection moulding process

15

3 h : Measurement of a further 100 disks after 180 minutes of a continuous injection moulding process

Table 1

Example no.	E field starting value ¹ [kV/m]	E field value after 3 h ² [kV/m]	Defects on the inner edge ³
1	-13.0	11.5	no
2	25.5	41.0	yes

20 ¹ Average value (integral) of the electrical field of the first 100 disks measured

² Average value (integral) of the electrical field of 100 disks measured after 180 minutes of the continuous injection moulding process

25 ³ Wetting defects on the inner edge of the disk after application of dyestuff; detected by means of light microscopy evaluation

Patent Claims

1. Substrate material, characterized in that the integral value of the electrical field, measured at a distance of 100 mm from the corresponding injection-moulded articles which have been produced within the first 5 minutes of a continuous injection moulding process, is between -30 and 0 kV/m, and preferably between -20 and 0 kV/m.
2. Substrate material according to claim 1, characterized in that after 180 - 185 minutes of the continuous injection moulding process, the value of the electrical field, measured at a distance of 100 mm from the corresponding injection-moulded articles, is between 0 and +25 kV/m, and particularly preferably between 0 and 18 kV/m.
3. Substrate material according to claim 1, which, after 3 hours, does not exceed an integral average value of the electrical field of +18 kV/m, measured at a distance of 100 mm from the corresponding injection-moulded articles.
4. Substrate material according to claim 1, characterized in that the integral value of the electrical field, measured at a distance of 100 mm from the corresponding injection-moulded articles which have been produced within the first 5 minutes of a continuous injection moulding process, is between -30 and 0 kV/m, and after 180 - 185 minutes of a continuous injection moulding process the value of the electrical field, measured at a distance of 100 mm from the corresponding injection-moulded articles, is between 0 and +25 kV/m.
5. Substrate material according to claim 1, characterized in that the integral value of the electrical field, measured at a distance of 100 mm from the corresponding injection-moulded articles which have been produced within the first 5 minutes of a continuous injection moulding process, is between

- 5 -30 and 0 kV/m, and after 180 - 185 minutes of a continuous injection moulding process the value of the electrical field, measured at a distance of 100 mm from the corresponding injection-moulded articles, is between 0 and +25 kV/m and which, after 3 hours, does not exceed an integral average value of the electrical field of +18 kV/m, measured at a distance of 100 mm from the corresponding injection-moulded articles.
- 10 6. Substrate material according to claims 1 to 5 for transparent mouldings to be coated.
7. Polycarbonate as a substrate material according to claims 1 to 6.
8. Use of the substrate material according to claims 1 to 7 for the production of mouldings and extrudates.
- 15 9. Mouldings and extrudates obtainable from the substrate materials according to claims 1 to 8.
- 20 10. Optical data storage medium or diffusing screen obtainable from the substrate materials according to claims 1 to 7.